... for a brighter future


U.S. Department of Energy

A U.S. Department of Energy laboratory
managed by The University of Chicago

Workshop on:

Novel Science with Polarized X-rays

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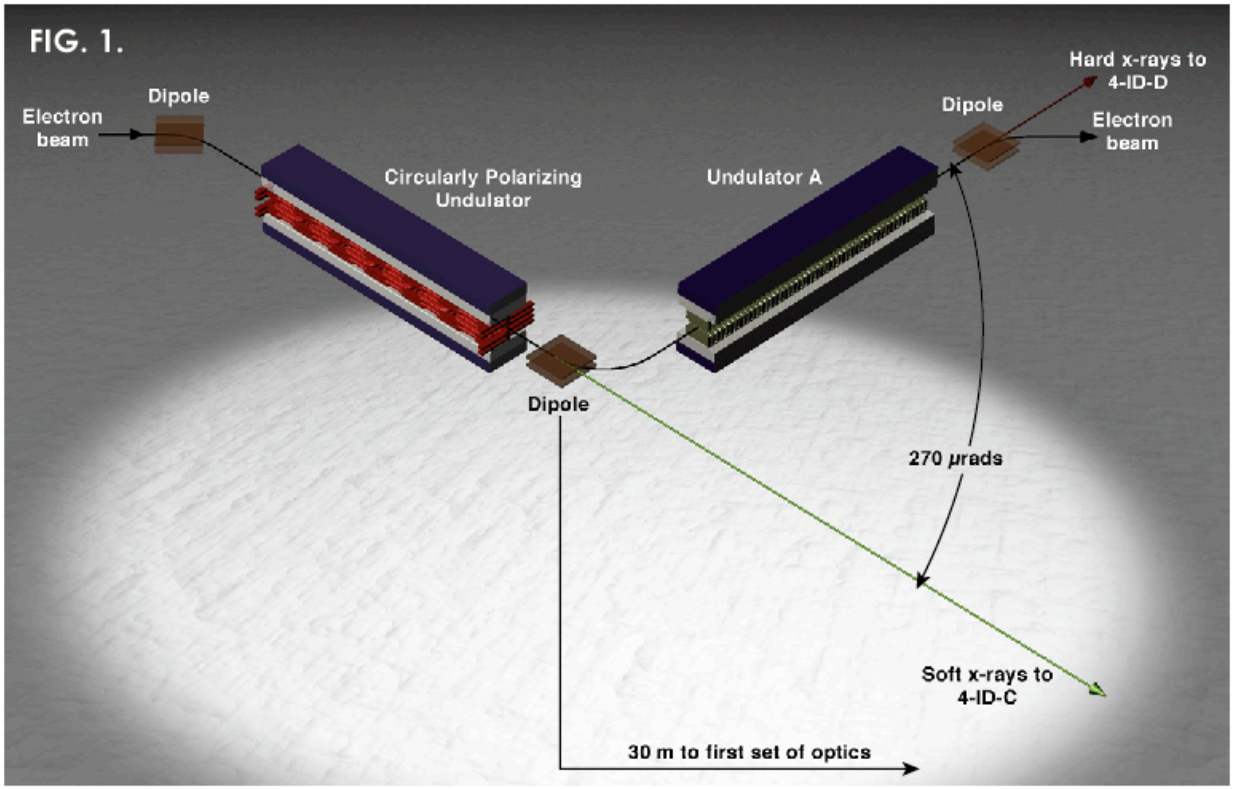
Advanced Photon Source

Polarized X-rays at the APS

Sector 4 is a dedicated facility to provide linear and circular polarized x-rays



4-ID-D:
2.5 - 40 keV

4-ID-C:
0.5 - 3 keV

Polarization dependent probes of electronic/magnetic properties

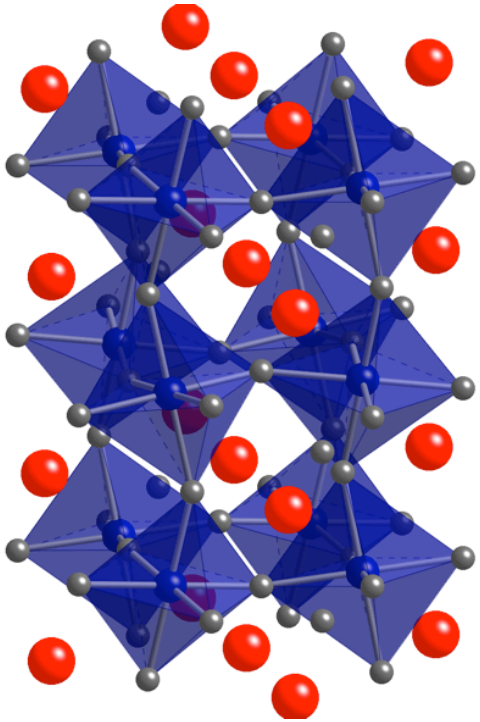
Outline

- Science being done now
- Science that can't be done
- What we need to do it

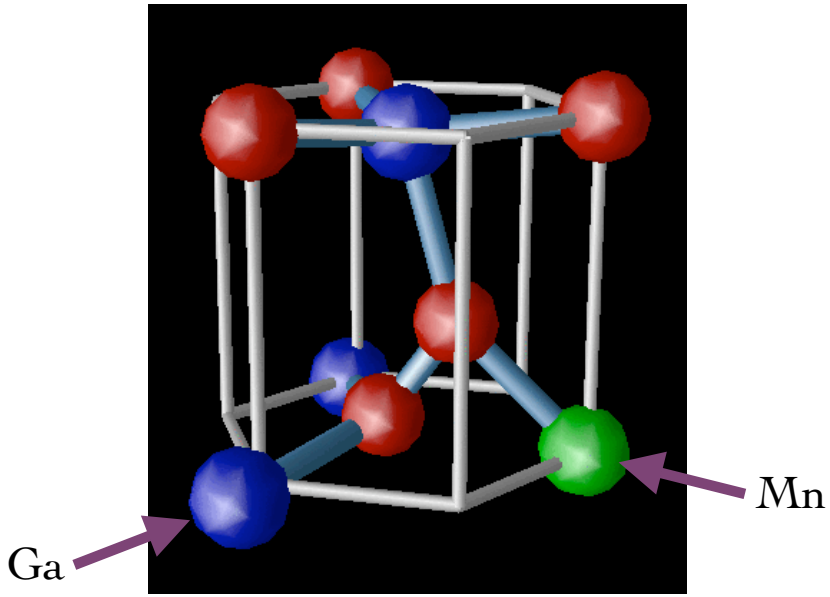
Complex Materials

Understanding materials key to basic science and new technologies

Complex Oxides



Ferromagnetic Semiconductors

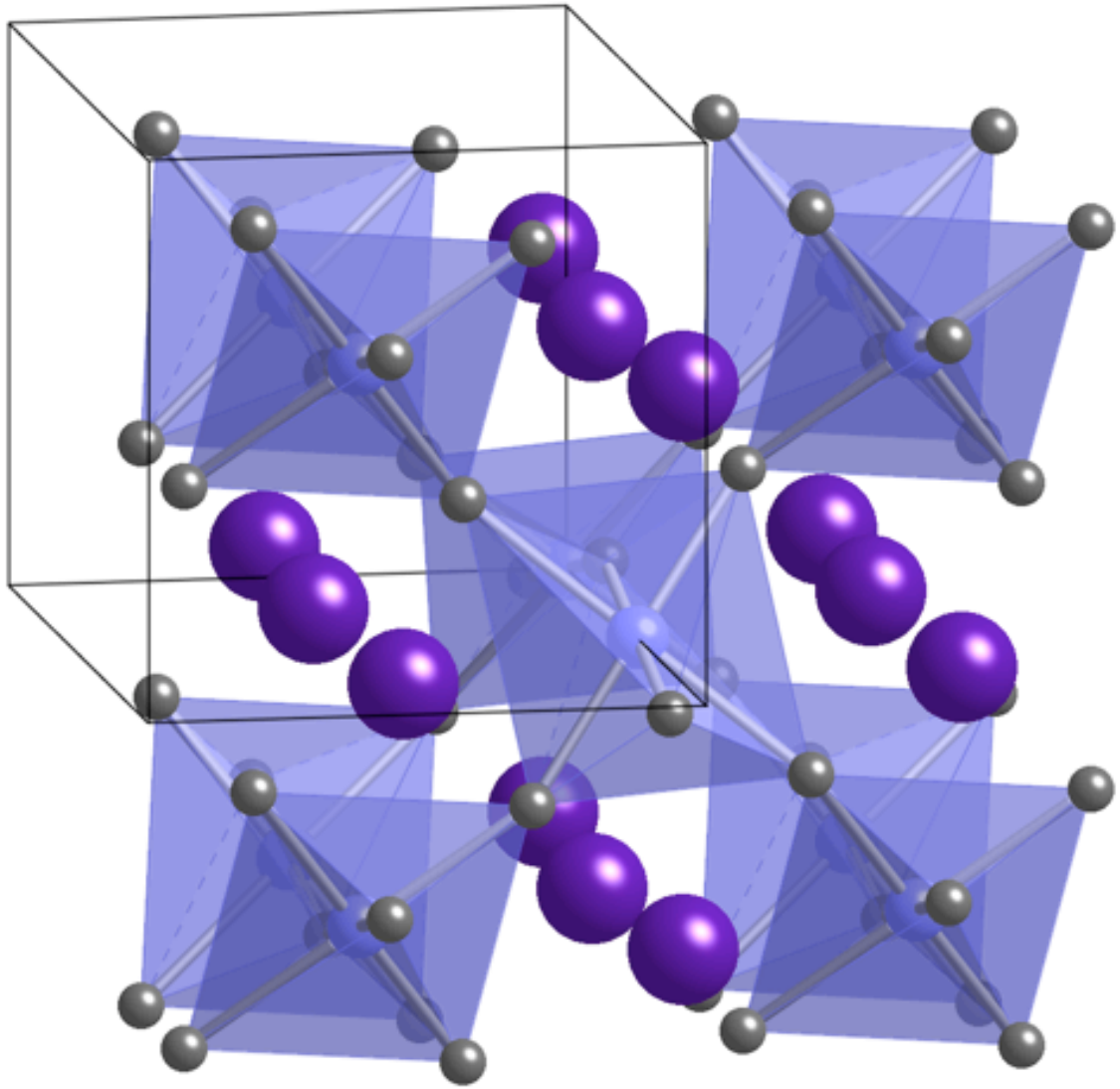


Polarization dependent x-ray measurements are crucial to understanding the physics of these materials!

Information from Polarized X-rays

- **Element-specific**
- **Bond-specific**
- **Electronic structure**
- **Magnetism**
  - ferromagnetism with circular polarization
  - anti-ferromagnetism with linear polarization
- **Dynamics at the ps level?**

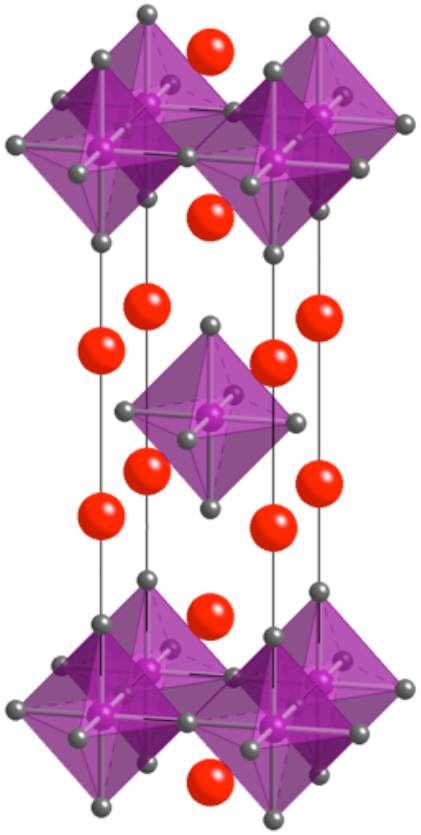
Electronic Structure of Oxides

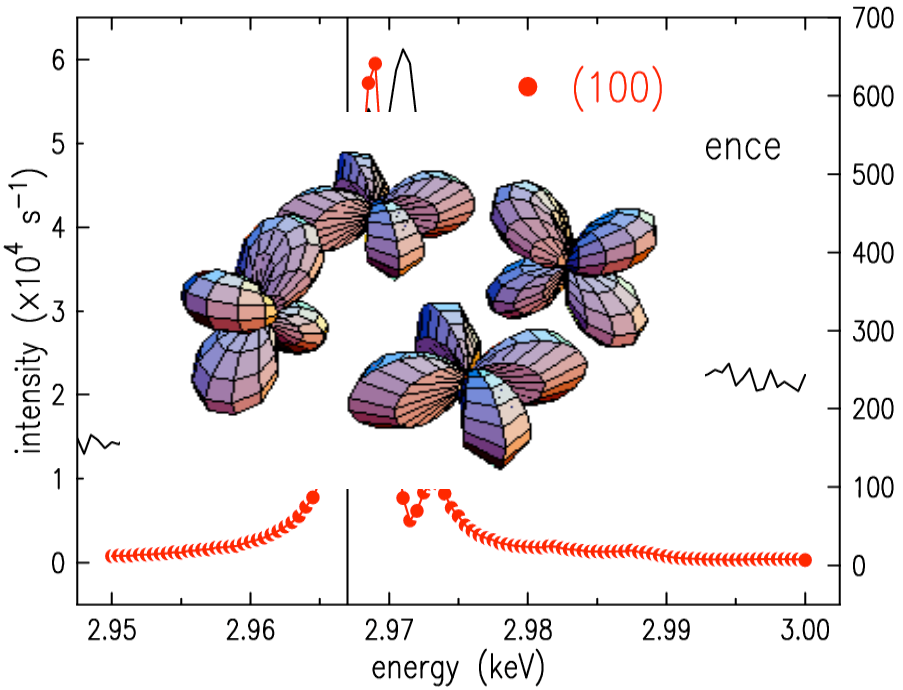


J.W Freeland (APS), K. Gray, J.F. Mitchell (MSD), M. van Veenendaal (APS/NIU)

Orbital Ordering in the Ruthenates

How do electronic orbitals arrange in a 2 dimensional lattice?





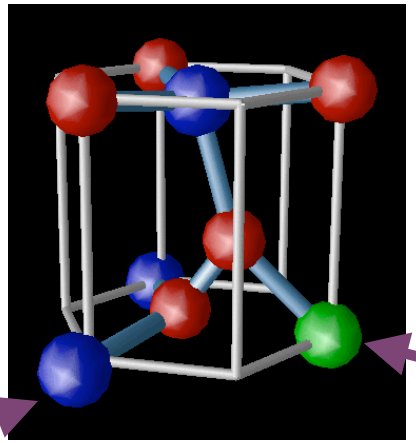
PRL **95,** 136401 (2005) PHYSICAL REVIEW LETTERS week ending 23 SEPTEMBER 2005

Orbital Ordering Transition in Ca_2RuO_4 Observed with Resonant X-Ray Diffraction

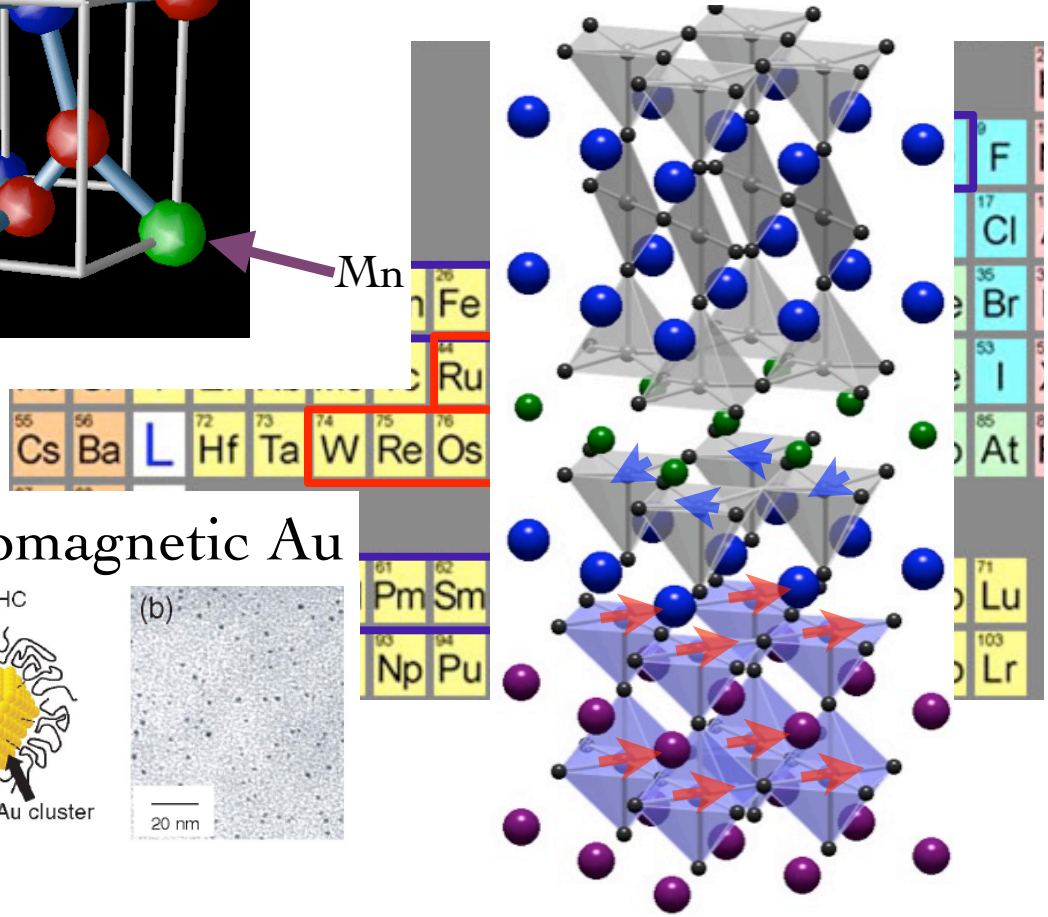
I. Zegkinoglou,[1] J. Strempfer,[1] C. S. Nelson,[2] J. P. Hill,[3] J. Chakhalian,[1] C. Bernhard,[1] J. C. Lang,[4] G. Srajer,[4] H. Fukazawa,[5] S. Nakatsuji,[5] Y. Maeno,[5,6] and B. Keimer[1]

Future Science

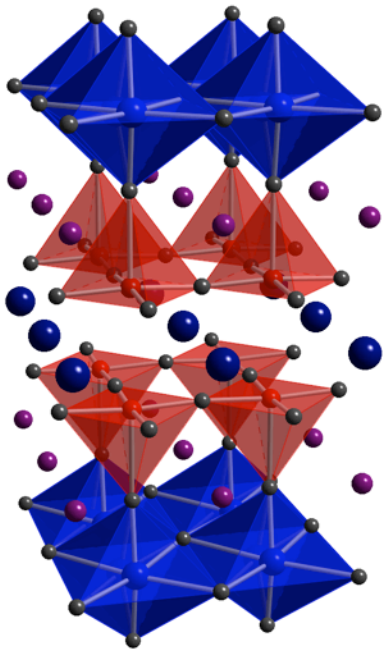
Ferromagnetic Semiconductors



Novel Oxide Heterostructures

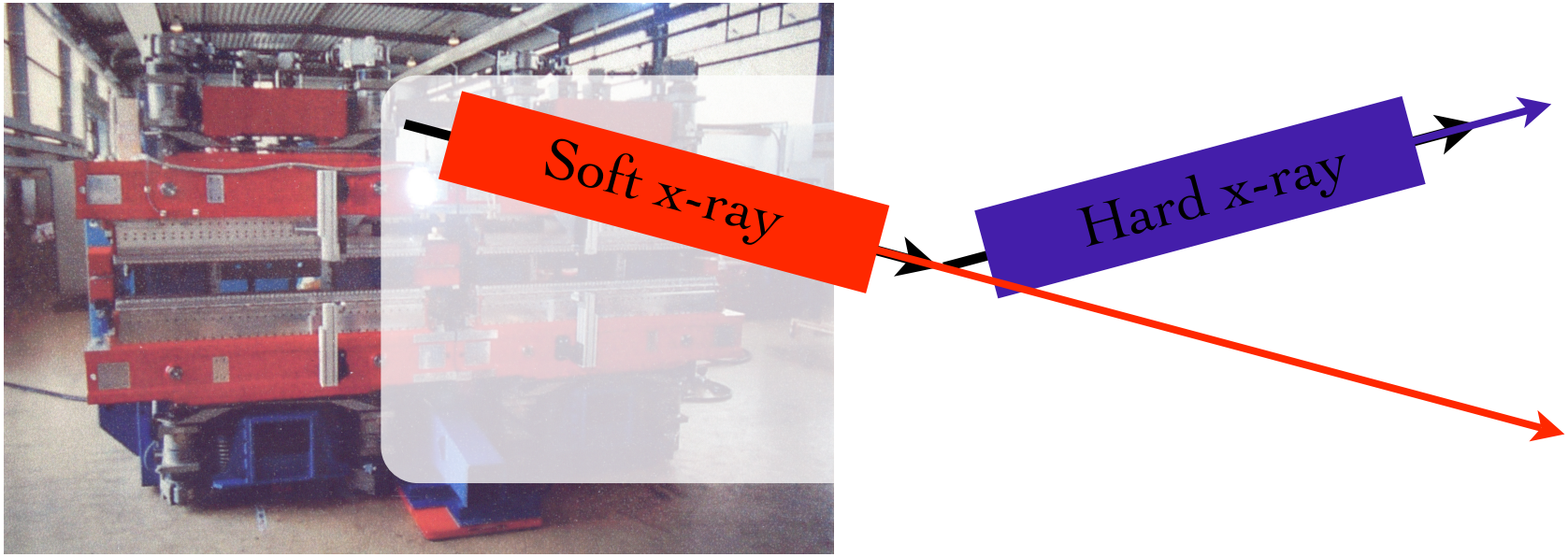


Ferromagnetic Superconductor $RuGd_2SrCu_2O_8$



Ferromagnetic Au

New Undulators



Undulator specifications:

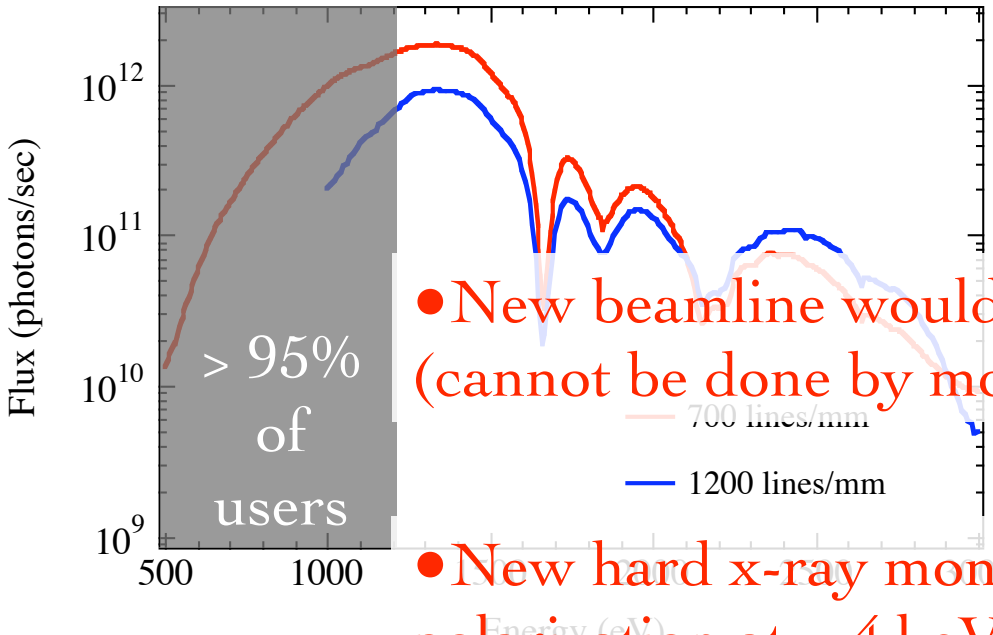
- Provide: LCP,RCP, horizontal and vertical linear
- Polarization switching at > 10 Hz, switching time < 10 ms
- Energy range: soft (0.4 - 1.5 keV) & hard (2 - 14 keV)

Can it be done in one straight section?

What We Gain

- **Increased flux**
- **Expanded polarization control:**
  - all polarizations on demand at all energies
- **Faster switching**
  - lock-in detection for small signals
- **Expanded energy range:**
  - soft x-ray: 0.4 - 1.5 eV
  - hard x-ray: 2 - 14 keV
- **ERL?: Dynamics at ps level**

Beamline Upgrades



- New beamline would capture > 10^3 increase in flux (cannot be done by modifying current beamline)
- New hard x-ray monochromator to maintain polarization at < 4 keV
- Superconducting magnet (> 10 T) with low temperature (< 1K) capability

Conclusions

Enhanced polarized x-ray facilities enable new understanding of complex materials